DISTRIBUTION AND PHYSICAL CHARACTERISTICS OF THE BEVERLY HERD OF CARIBOU IN FEBRUARY AND MARCH 1986

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CANADIAN WILDLIFE SERVICE

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ABSTRACT

The physical condition, pregnancy rates, and general health of the Beverly Herd of barren-ground caribou (Rangifer tarandus groenlandicus) was monitored in March 1986 with a sample of 150 caribou obtained on the forested winter range at Cobb Lake (61°54'N, 108°45'W), Northwest Territories. Fat reserves were in general somewhat higher than in December 1985, but lower than a year earlier. They were similar to the relatively low fat reserves recorded in the winter of 1982-83. Young (1 and 2 years) and old (5+ years) males were most affected by the relatively early and deep snow in 1985-86. The poorer fat reserves resulted in a pregnancy rate of only 79% in females over 2 years old. Pregnant females had better fat reserves than their non-pregnant counterparts. One female had no uterus and another a probable resorption, both rare occurrences in caribou. There was evidence that the condition of caribou may be influenced from harassment by warble flies (Oedemagena tarandi) or the effects of their larvae.

The distribution of the Beverly Herd changed little between late November and late March. The highest densities occurred in the Nonacho Lake region and surrounding 50 km. That region had favourable snow conditions whereas more easterly portions of the winter range had snow as deep as 98 cm. The caribou spent most of the winter between the deep snow zone to the east and a region with young forests to the west.

INTRODUCTION

The physical condition of the Beverly Herd of barren-ground caribou was monitored each December and March since 1982 (Thomas and Kiliaan 1982; Thomas 1983; Thomas et al. 1983; Thomas and Kiliaan 1984a, 1984b; Thomas and Kiliaan 1985a, 1985b; Thomas et al. 1986). The purpose of the monitoring is to assess changes in condition of the herd while on the winter range. Typically the herd enters the forested portion of the winter range in late October or November and begins to migrate from it in late March. The adequacy of the winter range to support the present population of 250,000 to 420,000 (Heard, pers. comm.) caribou is judged on the changes in their weight and fat reserves from early December to mid-March. A basis for comparison were changes in physical condition of the adjacent Kaminuriak Herd during the winter of 1967-68 (Dauphiné 1976). Fire was then not considered to be a factor in the winter ecology of that herd because of the relatively low average burn rate of 0.2% (Miller 1976).

This study is one phase of a long-term investigation of the effects of forest fires on the winter range of the Beverly Herd. This report gives the results of the ninth sample of caribou in March 1986. It completes the schedule of four winter seasons of major sampling, although a reduced level of monitoring may continue in 1986-87 as the project 'winds down'. Also reported is a brief summary of the herd's distribution in late winter of 1985-86 and information on snow conditions.

This report contains preliminary results which will be checked before a final report is produced in 1987. Statistical treatment of the

data will appear in the final report. Mean (average) values and the standard errors (SE) are given in this report. The SE values are indicators of how reliable the mean values are. With a sample size of 30 or more, SE x 2 gives the expected range of the sample mean in 95 of 100 cases. For example, if the mean is 100 and SE = 5, the mean of the sampled population is expected to lie between 90 and 110 in 95 of 100 cases. Where the sample size is less, the mean is less reliable. For example, with a sample size of five, the reliable range of the mean is calculated by SE x 2.8.

METHODS

Distribution and movements of the Beverly Herd during the winter of 1985-86 was monitored in December (Thomas et al. 1986), and from February 6 to 8 and March 17 to 29 (Table 1). Elevations above ground level (agl) for the Cessna 185 aircraft generally were about 300 m, though some transects were flown at up to 1000 m agl to facilitate radio monitoring of caribou collared on the range of the Kaminuriak Herd, some of which were potentially in the area surveyed.

Snow measurements and forest ages were obtained at various locations throughout the winter range in the Northwest Territories (NWT) during the surveys in February and March.

The best location for a field camp was identified on March 17 and it was positioned the next day at Cobb Lake (61°54'N, 108°45'W). From 19 to 22 March, 43, 44, 33, and 30 caribou were necropsied daily at the site with the assistance of six members of the Fort Smith Hunters and Trappers Association. Procedures were the same as in earlier sampling

Table 1. Aircraft used in February and March 1986 for surveys of caribou distribution and snow depths and to collect 150 caribou.

Date	Aircraft type	Flight time (hr)	Purpose: brief route description (lake names)
February 6	C185	7.0	Survey: Fort Smith (Sm), Nonacho, Tyrrell, Munn, Reliance, Sm
February 7	C185	6.7	Survey: Sm, Halliday, Sid, Nonacho, Gray, Sm
February 8	C185	6.1	Survey: Brazen, Obre, Smalltree, Narwhal, Sm
March 17	C185	7.6	Survey: Porter, La Loche, Thekulthili, Sm
March 18	S.O.	6.6	Position camp: Sm, Cobb, Sm (2 trips)
March 20	S.O.	3.3	Haul caribou carcasses: Sm, Cobb, Sm
March 22	S.O.	6.6	Haul caribou carcasses and break camp: Sm, Cobb, Sm (2 trips)
March 23	S.O.	9.9	As above: Sm, Cobb, Sm (3 trips)
March 25	C185	8.1	Survey and haul carcasses: Sm, Great Slave, Cobb, Sm
March 26	C185	7.8	As above: Sm, Firedrake, Damant, Cobb, Sm
March 28	C185	7.2	Survey: Sm, Kasba, Beauvais, Sm
March 29	C185	5.4	Monitoring radio collars: Sm, Anderson, Satin, Noman, Sm

periods (Thomas and Kiliaan 1982), except that no measurements other than weight were obtained and blood was collected after the caribou were hauled to the camp site. Samples of muscle and liver were taken for analyses of organochlorines and muscle chemistry. The examination of livers and lungs for cysts of the tapeworm Taenia hydatigena and Echinococcus granulosis was external only except that the soft lung tissue was also felt for the relatively hard cysts.

The ages are final ones as determined by tooth wear and eruption (1-2 years) and from stained sections of the roots of the first molar.

The frequencies of 67 radios placed on caribou in 1984 and 1985 on the range of the Kaminariak Herd were monitored on five survey flights. Surveys on February 6 and 7 were at 300 m agl except for one pass at 1000 m over the region with the highest caribou density. The survey on February 8 was flown at 1000 m agl. The receiver was available for flights conducted at 1000 m agl on March 28 and 29, including coverage of the region of highest caribou density.

RESULTS AND DISCUSSION

Age Structure of the Sample

Calves and, to a lesser degree, yearlings were not shot in proportion to their occurrence because of their low meat yield and leaner carcass. There were equal numbers of males and females in the 2 and 3 year old classes (Fig. 1). Numbers of males in older age classes declined rapidly whereas the decline in females was gradual. The 1980, 1977, and 1976 cohorts were relatively well represented. The 1978 and 1975 cohorts were each represented by only two caribou.

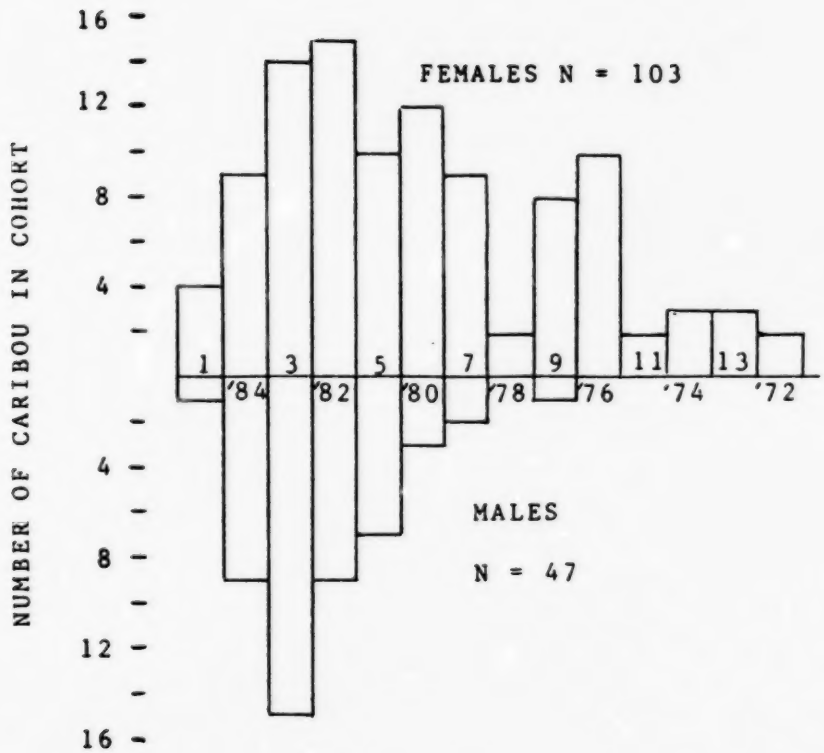

Figure 1. Age composition of the March 1986 sample of caribou obtained from the Beverly Herd at Cobb Lake, Northwest Territories. Age at the nearest birthday and year of birth alternate on the base line.

The smaller December 1985 sample suggested strong 1982 and 1979 cohorts and relatively weak cohorts of 1980 and 1975 (Thomas et al. 1986). Such interpretations are influenced by what a normal age distribution should be. The best data are those from the 1966-1968 study of the Kaminuriak Herd (Miller 1974).

Age histograms, such as Figure 1, provide insight into the relative survival of caribou produced in various years. The results can then be related to factors that influence fertility and mortality such as weather, predators, and parasites.

Physical Condition

Average back fat depths and kidney fat weights were lower in males than in females (Table 2). There was a gradual increase in those fat indices with age of males. All females over 2 years old had similar fat reserves. The largest reserves occurred in the oldest group of females, those 12 to 14 years old.

Changes in Physical Condition from December to March

Whole body weight was maintained over the winter in yearling males, but declines occurred in all older males (Table 2). There was little change in the body weights of females over the 3+ months of midwinter.

Depths of back fat increased from December to March in males aged 2½-3 years to 4½-5 years, whereas decreases occurred in yearlings. Females aged 2½ to 4½ years gained some back fat from mid-December to mid-March, whereas a decline occurred in females over 5½ years old. The

Table 2. Physical condition statistics for caribou of the Beverly Herd that were sampled in December 1985 and March 1986.

Sex and age (yr)	Body weight (kg)						Back fat depth (mm)						Kidney fat (g)					
	December 1985			March 1986			December 1985			March 1986			December 1985			March 1986		
	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)
F ½-1	36.8		(1)	44.0	2.5	(4)	0.0		(1)	1.3	0.3	(4)	19.6		(1)	23.3	4.3	(4)
M ½-1				44.0		(1)				0.0		(1)				17.0		(1)
F 1½-2	69.2	2.2	(4)	65.4	2.3	(9)	4.3	2.0	(4)	3.7	0.8	(9)	42.2	6.8	(4)	51.1	5.8	(9)
M 1½-2	69.1	1.5	(6)	70.7	2.0	(9)	4.0	0.8	(6)	1.9	0.5	(9)	46.7	4.7	(6)	42.6	4.0	(9)
F 2½-3	76.6	1.9	(6)	78.0	2.3	(14)	8.8	4.2	(6)	10.3	2.1	(14)	55.3	9.2	(5)	93.1	12.4	(14)
M 2½-3	88.8	3.0	(11)	80.9	1.6	(15)	1.1	0.2	(11)	2.1	0.5	(15)	39.7	3.4	(11)	58.7	5.1	(15)
F 3½-4	81.8	1.6	(12)	80.4	2.2	(15)	9.9	2.3	(13)	12.5	2.1	(15)	65.1	10.0	(13)	88.5	7.3	(15)
M 3½-4	98.1	2.8	(6)	95.0	3.7	(9)	1.3	0.3	(6)	3.8	1.0	(9)	54.0	2.9	(6)	63.3	7.1	(9)
F 4½-5	83.5	3.7	(4)	83.7	2.5	(10)	7.5	3.7	(4)	10.4	2.5	(10)	65.0	15.6	(4)	92.2	12.3	(10)
M 4½-5	104.8	2.5	(2)	100.1	1.1	(7)	1.0	0.0	(2)	4.1	1.4	(7)	46.9	5.6	(2)	75.9	6.0	(7)
F 5½-11	87.2	1.7	(18)	85.5	2.0	(23)	14.3	2.1	(18)	10.9	1.5	(23)	88.0	7.9	(16)	96.5	7.6	(23)
M 5½-11	112.7	1.2	(3)	104.0	3.7	(6)	5.0	2.3	(3)	4.7	1.4	(6)	91.0	15.6	(3)	79.7	8.6	(6)
F 12+	84.8	3.3	(6)	88.1	1.6	(20)	22.0	5.2	(6)	12.7	2.0	(20)	78.7	10.9	(6)	107.5	8.0	(8)

decline was from 23 mm to 13 mm in females 12 years old and older (Table 2).

The weight of fat around the kidneys (a measure of internal body fat) increased from December to March in all age and sex classes except yearling males and old males.

Back fat depths and weight of kidney fat increased in both sexes aged 2½ to 5 years. Decreases occurred in both fat depots in yearling males (1½-2 years old) and males over 5 years old. Back fat decreased in thickness while kidney fat weights increased in females over 5 years old. The probable explanation is that fat reserves in December were relatively low in caribou aged 2½ to 4½ years and they were able to recover the reserves somewhat over the 3 months of midwinter. Older females had good reserves in December and they were retained over the winter period. Yearling males and old males appeared to be most affected by the relatively early and deep snow in 1985-86.

The tendency of caribou to sharply increase internal fat reserves from December to March was noted in the 1984-85 sample (Thomas and Kiliaan 1985b). During the same period, back fat depths remained about constant.

Yearly Changes in Condition Indices

Average body weights in March 1986 were lower than in March 1985 in 12 of 13 sex/age classes (Table 3). In general, weights were somewhat lower than in the March 1984 Porter Lake sample, slightly higher than in the March 1982 sample, and considerably higher than in the March 1983 and the March 1984 sample obtained at Sifton Lake.

Table 3. Whole body weights of caribou in the Beverly Herd each March from 1982 to 1986.

Sex/age (yr)	Body weight (kg)																	
	March 1982			March 1983			March 1984[a]			March 1984[b]			March 1985			March 1986		
	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)
F 1	42.6	1.1	(13)	40.8	1.2	(5)	41.8	0.5	(4)				44.5	1.3	(3)	44.0	2.5	(4)
M 1	50.1	1.4	(7)	44.0	2.0	(2)	45.3	0.6	(4)				50.9	1.0	(4)	44.0		(1)
F 2	59.4	1.7	(13)	57.6	1.0	(15)	63.2	3.1	(9)	59.2	2.1	(3)	68.5	2.3	(10)	65.4	2.3	(9)
M 2	66.7	2.1	(12)	63.8	1.3	(22)	65.2	6.4	(5)	61.8	2.3	(4)	73.7	1.8	(9)	70.7	2.0	(9)
F 3	75.2	2.3	(8)	71.7	1.8	(12)	80.5	1.4	(11)	76.8	3.8	(2)	80.3	1.6	(22)	78.0	2.3	(14)
M 3	85.6	1.3	(25)	79.8	1.6	(19)	80.6	5.5	(6)	71.8	2.5	(6)	86.0	2.1	(19)	80.9	1.6	(15)
F 4	74.3	2.1	(2)	76.4	2.6	(11)	81.2	5.1	(3)	75.3	1.5	(4)	83.2	1.7	(20)	80.4	2.2	(15)
M 4	102.7		(1)	92.5	1.9	(10)	100.3	1.0	(4)	85.0	2.4	(3)	90.5	7.6	(3)	95.0	3.7	(9)
F 5	81.8	2.4	(10)	74.7	5.0	(6)	86.6	2.3	(13)	75.5		(1)	87.6	2.0	(10)	83.7	2.5	(10)
M 5	98.0	4.8	(2)	91.3	2.9	(4)	105.2	8.2	(3)	92.7	3.7	(3)	115.8	3.8	(2)	100.1	1.1	(7)
F 6-11	86.1	0.9	(33)	80.3	1.0	(43)	88.0	1.0	(43)	77.7	2.5	(8)	89.2	0.9	(49)	85.5	2.0	(23)
M 6-12							117.8	5.7	(4)				126.0		(1)	104.0	3.7	(6)
F >11	83.1	3.4	(6)	82.3	2.4	(8)	88.1	2.9	(5)				91.7	2.4	(10)	88.1	1.6	(8)

[a] Porter Lake sample.
[b] Sifton Lake sample.

Average back fat depths in relation to March results for previous years followed the same trend as weights except that the 1986 results were only marginally higher than those of the two previous samples with the lowest values (Table 4).

Kidney fat indices in March 1986 were lower than a year earlier in 10 of 13 cases (Table 5). They were similar to values recorded in March 1982 and in samples obtained in March 1985 at Sifton Lake.

Pregnancy Rates

None of nine yearling females was pregnant. The rate varied from 75 to 80% in the five older age classes and averaged 78.6% (N = 70). These rates are similar to rates recorded in December (Thomas et al. 1986), except in 2½-3 year old females where the sample size in December was only six.

Combining the results from December and March increases the sample size and permits comparisons with previous years (Table 6). The age-specific pregnancy rates in 1985-86 were lower than a year earlier in all seven age classes. They were similar to rates in 1982-83, which were the lowest recorded in the previous 5 years. The results confirm that pregnancy rates in barren-ground caribou can vary considerably and such variability should be considered in formulae used to calculate population size from estimated numbers of caribou on the calving grounds.

Table 4. Back fat depths of caribou in the Beverly Herd each March from 1982 to 1986.

Sex/age (yr)	Back fat depth (mm)														
	March 1982			March 1983			March 1984[a]			March 1984[b]			March 1985			March 1986		
	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)
F 1	1.2	0.4	(13)	0.3	0.3	(4)	1.0	0	(4)				2.0	0	(3)	1.3	0.3	(4)
M 1	0.4	0.2	(7)	1.4	1.0	(2)	1.5	0.5	(4)				2.3	1.3	(4)	0		(1)
F 2	2.8	0.9	(12)	1.9	0.5	(15)	8.0	3.0	(9)	2.3	0.3	(3)	7.4	1.9	(10)	3.7	0.8	(9)
M 2	1.3	0.5	(11)	1.2	0.4	(23)	1.2	0.5	(5)	0.8	0.3	(4)	2.0	1.0	(9)	1.9	0.5	(9)
F 3	17.9	4.7	(7)	8.9	2.9	(12)	19.7	3.3	(11)	11.5	1.7	(2)	18.0	1.7	(22)	10.3	2.1	(14)
M 3	1.1	0.3	(24)	0.5	0.2	(17)	1.8	0.6	(6)	1.2	0.6	(6)	3.1	0.6	(19)	2.1	0.5	(15)
F 4	13.5	12.5	(2)	12.5	2.5	(11)	22.3	6.9	(3)	13.8	1.3	(4)	18.9	1.9	(20)	12.5	2.1	(15)
M 4	0		(1)	0.4	0.2	(10)	2.5	1.5	(4)	1.0	0	(3)	1.7	0.7	(3)	3.8	1.0	(9)
F 5	14.8	3.0	(9)	8.2	4.8	(6)	18.8	2.4	(13)	2.0		(1)	20.1	2.0	(10)	10.4	2.5	(10)
M 5	0		(2)	0.3	0.3	(4)	14.3	7.1	(3)				4.5	2.5	(2)	4.1	1.4	(7)
F 6-11	18.2	1.8	(32)	10.2	1.2	(44)	21.6	1.3	(43)	7.5	3.3	(8)	19.0	1.3	(49)	10.9	1.5	(23)
M 6-12							19.3	5.0	(4)	0.3	0.3	(3)	6.0		(1)	4.7	1.4	(6)
F >11	13.7	4.6	(6)	4.1	1.7	(8)	22.4	3.5	(5)				15.8	2.7	(10)	12.7	2.0	(8)

[a] Porter Lake sample.
[b] Sifton Lake sample.

Table 5. Kidney fat indices of caribou in the Beverly Herd each March from 1982 to 1986.

Sex/age (yr)	Kidney fat index																	
	March 1982			March 1983			March 1984[a]			March 1984[b]			March 1985			March 1986		
	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)	Mean	SE	(N)
F 1	32.6	5.3	(13)	28.0	4.2	(5)	25.5	4.6	(4)				36.2	5.0	(3)	22.7	3.2	(4)
M 1	27.7	2.2	(7)	25.7	9.6	(2)	22.8	5.2	(4)				31.7	8.9	(4)	18.5		(1)
F 2	36.4	3.5	(9)	37.8	2.3	(15)	52.2	7.4	(9)	41.6	11.6	(3)	58.6	8.8	(10)	38.4	4.1	(9)
M 2	38.8	2.8	(9)	26.5	2.1	(23)	28.5	2.7	(5)	29.2	5.5	(4)	34.9	3.3	(9)	29.3	2.6	(9)
F 3	69.0	5.8	(7)	53.0	7.0	(12)	74.8	7.2	(11)	45.4	6.0	(2)	78.9	5.7	(22)	65.6	8.8	(14)
M 3	32.8	2.9	(22)	27.3	2.1	(19)	42.2	4.0	(6)	42.9	4.0	(6)	40.6	2.1	(19)	35.7	2.7	(15)
F 4	48.4	21.7	(2)	56.1	7.2	(11)	95.4	18.5	(3)	73.4	9.3	(4)	76.7	5.3	(20)	64.5	5.2	(15)
M 4				30.7	2.7	(10)	51.0	6.7	(4)	36.0	4.7	(3)	41.1	4.8	(3)	33.7	3.0	(9)
F 5	61.5	6.1	(10)	38.2	11.7	(4)	75.6	7.0	(13)	48.3		(1)	80.2	7.3	(10)	63.4	8.3	(10)
M 5	21.4		(1)	34.6	4.6	(4)	54.9	16.1	(2)				38.1	3.2	(2)	38.3	2.9	(7)
F 6-11	64.3	2.8	(32)	58.0	3.3	(42)	74.2	3.7	(43)	50.6	7.6	(8)	73.0	3.6	(49)	58.9	4.0	(23)
M 6-12							51.5	2.6	(4)	24.9	3.0	(3)	34.8		(1)	35.8	3.4	(6)
F > 11	52.7	8.4	(5)	37.1	6.5	(8)	60.6	3.6	(5)				55.7	6.0	(10)	66.6	4.5	(8)

[a] Porter Lake sample.
[b] Sifton Lake sample.

Table 6. Pregnancy rates (%) of six age classes of caribou in the Beverly Herd from 1981-82 to 1985-86 (sample sizes in parentheses).

Age (yr)	1981-1982	1982-1983	1983-1984[a]	1983-1984[b]	1984-1985	1985-1986
1½-2	8 (13)	0 (15)	0 (10)	33 (9)	31 (16)	0 (13)
2½-3	75 (8)	50 (12)	75 (8)	100 (11)	83 (29)	65 (20)
3½-4	50 (2)	73 (11)	89 (9)	100 (3)	90 (31)	75 (28)
4½-5	90 (10)	33 (6)	94 (16)	92 (12)	100 (15)	79 (14)
5½-11	97 (33)	82 (44)	75 (24)	98 (43)	89 (65)	81 (41)
>11	83 (6)	88 (8)	100 (2)	100 (5)	100 (16)	79 (14)
>3	92 (51)	77 (69)	84 (51)	97 (63)	92 (127)	78 (97)

[a] Northern segment sampled at Sifton Lake.
[b] Southern segment sampled at Porter Lake.

Pregnancy Rates in Relation to Physical Condition

Average condition indices were significantly higher in pregnant females compared with non-pregnant ones (Table 7). All females were grouped in two age classes to provide adequate numbers of non-pregnant individuals. Differences between the two groups were greater in the 3-5 year class than the older class because one non-pregnant female aged 12 years was in good condition. It was in a group of caribou containing a female with no uterus (a genetic or developmental abnormality) and another with a probable resorption of an embryo. The uterus of that female contained an estimated two litres of yellow, milky fluid. There was no trace of a fetus or an embryo.

Sex Ratio of Fetuses

The sex ratio of all fetuses was 36M:38F. It was 9M:14F in the combined 3 and 4 year classes, similar to the 15M:24F ratio in those age classes in March 1985. These data suggest that young females produce significantly more female offspring than male calves. Large sample sizes are needed to detect any age-related differences in fetal ratios. For example, the ratio was 7M:12F in the 9-11 age class and 6M:0F in the 12+ age group (Table 8).

Fat reserves were higher in females carrying female fetuses than in those with male fetuses, but the difference was significant ($P < 0.05$) only for the kidney fat index (Table 9).

Table 7. Condition indices of pregnant and non-pregnant female caribou in the Beverly Herd sampled in March 1986 at Cobb Lake, Northwest Territories.

Age class (yr)	Sample size		Body weight (kg)				Back fat depth (mm)				Kidney fat (g)			
			Pregnant		Not pregnant		Pregnant		Not pregnant		Pregnant		Not pregnant	
	Pregnant	Not pregnant	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
3-5	31	7[a]	82.7	1.2	68.6	1.7	12.9	1.3	2.1	1.1	100.1	6.2	47.4	3.7
> 5	43	7[b]	87.4	1.0	78.1	2.6	12.6	1.2	7.4	3.1	103.3	5.4	72.0	9.0

a Excluding one female with a probable resorption.
b Excluding one female with no uterus.

Table 8. The sex ratio of fetuses in six age classes of caribou sampled from the Beverly Herd in March 1986.

Age of female (yr)	Number of fetuses by sex: Male	Female
3	4	7
4	5	7
5	4	4
6-8	10	8
9-11	7	12
12+	6	0

Table 9. Physical condition indices of female caribou carrying male (N = 36) and female (N = 38) fetuses in March 1986.

Condition index of females	Sex of fetus	Mean	SE
Body weight (kg)	Male	86.2	1.2
	Female	84.7	1.1
Back fat depth (mm)	Male	11.8	1.3
	Female	13.5	1.1
Kidney fat weight (g)	Male	96.6	6.3
	Female	107.1	5.1
Kidney fat index	Male	61.7	3.5
	Female	71.0	3.5

Parasites

As in previous years, the number of warble fly (Oedemagena tarandi) larvae under the skins of caribou increased sharply from December to March in most sex/age classes. Numbers were high in 1 and 2 year old caribou and in older males (Table 10). They were intermediate in numbers in males 3-5 years old and lowest in females 3 years old and older. The progressive decline in larvae numbers with age in females that was observed in December was no longer evident. Therefore, the growth of larvae is slower in old females than in younger ones or they are infected later.

Number of warble larvae in March 1986 samples were about the same as in other years (Table 11). The relatively high numbers observed in December compared with previous years did not continue in March. The probable explanation is that growth of larvae occurred earlier in 1985-86 compared with previous years. The earlier tentative conclusion that warble fly numbers were higher in the summer of 1985 than in the previous four summers (Thomas et al. 1986) probably was incorrect.

The possible effect of varying degrees of warble fly harassment on the fat reserves of caribou was investigated by comparing fat reserves in caribou with greater and fewer than the median number of warble larvae for each age class. The median number in this case has about equal numbers of values higher and lower than it. The assumption is that numbers of larvae are directly related to the degree of harassment experienced by individuals. We don't know if this is a valid assumption. The direct effect of the larvae on the individual is not believed to be important unless there is a severe infestation.

Table 10. Changes from December 1985 to March 1986 in the number of warble larvae under the hide of Beverly Herd caribou and the incidence of liver and lung cysts in March 1986.

	December 1985	March 1986	Incidence of cysts in: Liver	Lungs
F ½-1	31 (1)	183 ± 40 (4)	0/4	0/4
M ½-1		150 (1)	0/1	0/1
F 1½-2	34 ± 4 (4)	154 ± 41 (9)	1/9	0/9
M 1½-2	44 ± 15 (6)	152 ± 28 (9)	1/9	0/9
F 2½-3	17 ± 9 (6)	34 ± 7 (14)	1/14	0/14
M 2½-3	19 ± 4 (11)	74 ± 19 (15)	0/15	0/15
F 3½-4	8 ± 3 (13)	40 ± 5 (15)	3/15	2/15
M 3½-4	15 ± 6 (5)	81 ± 20 (9)	2/9	0/9
F 4½-5	4 ± 3 (4)	22 ± 6 (10)	1/10	1/10
M 4½-5	118 ±112 (2)	93 ± 24 (7)	3/7	0/7
F 5½-11	2 ± 1 (17)	33 (43)	17/43	4/43
M 5½-11	133 ± 50 (3)	234 ± 41 (6)	0/6	0/6
F 12+	2 ± 1 (6)	44 ± 16 (8)	1/8	0/8

Table 11. Average number of warble larvae in caribou of the Beverly Herd sampled each March from 1982 to 1986 (sample sizes in parentheses).

Sex/age (yr)	1982	1983	1984[a]	1985	1986
F 1	137 (13)	120 (4)	114 (4)	56 (3)	183 (4)
M 1	139 (6)	118 (2)	128 (1)	104 (4)	150 (1)
F 2	106 (11)	145 (15)	101 (9)	90 (10)	154 (9)
M 2	148 (9)	192 (21)	199 (5)	201 (9)	152 (9)
F 3	56 (7)	74 (11)	70 (11)	28 (22)	34 (14)
M 3	102 (21)	85 (19)	200 (6)	101 (19)	74 (15)
F 4	91 (2)	61 (11)	26 (3)	41 (20)	40 (15)
M 4		88 (10)	62 (4)	56 (3)	81 (9)
F 5	23 (10)	58 (6)	25 (13)	37 (10)	20 (10)
M 5		80 (4)	169 (3)	118 (2)	93 (7)
F 6-11	33 (31)	53 (40)	32 (43)	32 (49)	33 (43)
M 6-11			435 (4)	208 (1)	104 (6)
F >11	77 (6)	35 (7)	20 (5)	30 (10)	44 (8)

[a] Porter Lake sample.

According to Dieterich and Hass (1981), warbles can affect the health of caribou through nutritional imbalance, allergenic responses, and secondary infections. Weakened animals may be more susceptible to other diseases and predation.

Caribou 1 and 2 years old and males over 5 years old were excluded from the analysis because they have higher numbers of warble larvae and inadequate sample size for separate analyses. Differences in condition between high and low infestation levels were significant ($P < 0.05$) for females 3-5 years old and for all females over 2 years old (Table 12). There was little difference between the two levels in males 3-5 years old and in females over 5 years old.

Liver cysts of the tapeworm Taenia hydatigena occurred in 21.3% of the caribou. The highest incidence was in males 5 years old (43%) and females 6-11 years old (40%) (Table 10). Only one cyst was detected in 22 of the 32 caribou affected. The others contained two cysts except for individuals (1 each) with 3, 4, and 5 cysts. The incidence was considerably lower than the 44% observed in the December sample, but higher than the 14% noted in March 1985. The large changes in cyst incidence and the presence of degenerating scars in the liver suggest that larvae do not remain in the liver for prolonged periods. Cysts are also present at various locations in the abdominal cavity.

Hydatid cysts of the tapeworm (Echinococcus granulosis) occurred in 4.7% of the caribou sampled (Table 10). All were in females, whose ages were 4, 4, 5, 6, 6, 10, and 11 years. Six of the caribou had one or two minor cysts 1 cm to 3 cm in average diameter. The other female (age 11 years) contained six cysts of average diameters ranging from

Table 12. Fat reserves (mean ± SE) of caribou having relatively low and high infestations of warble larvae for that age class, March 1986[a].

Sex/age class	Sample size	Back fat depth (mm)		Kidney fat index	
		low	high	low	high
F 3-5	19, 20[b]	14.0 ± 1.9	7.6 ± 1.4	74.2 ± 6.5	55.5 ± 4.5
M 3-5	16, 15	2.7 ± 0.6	3.5 ± 0.8	36.6 ± 2.6	34.8 ± 2.1
F 6+	26, 25	12.0 ± 1.6	11.3 ± 1.6	63.3 ± 4.1	58.2 ± 3.7
F all	45, 45	12.8 ± 1.2	9.7 ± 1.1	67.9 ± 3.7	57.0 ± 2.8

[a] Relatively low and high levels were obtained for age classes 3, 4, 5, 6-8, 9-11, and 12+ years and then the data were combined.
[b] For low and high numbers of larvae, respectively.

4.5 cm to 7.5 cm. Such massive infestations usually cause reduced vigour. However, the female was of average weight, back fat depth (5 mm) was below average, and kidney fat (102 g) was above average. The two infected 4 year old caribou were in relatively poor condition and the 5 year old was slightly below average in fat stores. The health of young females seemed to be the most affected by the presence of hydatid cysts. The same group was most affected by warble larvae. There is always the problem of cause and effect in these relationships: was condition affected by the parasites or were caribou in relatively poor condition more susceptible to parasites?

The incidence of hydatid cysts in March 1986 (4.7%) is comparable with 2.6% in the December 1985 sample and 4.3% in the March 1985 sample. The incidence was 4.1% (16/390) in combined samples from 1985 to 1986.

Distribution of Caribou in Winter 1985-86

All trails and tracks observed in the snow in early December, suggested that the Beverly Herd entered the winter range in late October or early November in the Nonacho Lake area and as far east as Porter Lake. There was a report of caribou travelling southeast through the northeast corner of Saskatchewan in early December (T. Trottier, Caribou Management Board minutes) but they must have travelled to the east of Selwyn and Wholdaia lakes because there were no trails in the snow on December 4 between 60°N and 61°N and west of 104°. They may have been a segment of the Kaminuriak Herd that wintered in Manitoba in 1985-86.

On December 6, a northern segment, travelling south in the Snowdrift River/Nonacho Lake region, met a larger southern segment whose northern leaders were travelling north. The northern segment was swept up by the other group and by December 17, tens of thousands of caribou were travelling north on northern Nonacho and Noman lakes. Caribou occurred in a large area from 62°18' to south of 60° and from Gagnon, Thekulthili, and Brazen lakes in the west to Gray, Manchester, and Scott lakes in the east. The main concentration at Noman Lake was heading towards the tundra in the Tent Lake/Snowdrift River region. Such forays from forest to tundra had occurred in the same region in late December 1983 and between mid-January and mid-February in 1985.

Surveys on February 6, 7, and 8 revealed that the distribution had changed little from that in December (Fig. 2). There was no major concentration such as last seen on December 17. The surveyed areas with highest densities were Alcantara Lake, south of Gagnon Lake and north of Siltaza Lake. Caribou were widely scattered throughout the range between 60° and 62°30' and 108° and 110°30', except for the burned region in the southwest, i.e. the Hill Island Lake region. Only a few scattered groups of caribou were seen on the 60°N transect, but old and fresh trails were noted from 109° to 104°W. Density of caribou was low in that region. The most common movement direction elsewhere was northwest, but some caribou in the south were travelling east-southeast.

A survey on March 17 and others later in the month revealed little change in distribution from early February (Fig. 3). The largest concentration of caribou was north of the Taltson River and west of Gray Lake. Fairly high densities occurred between Hjalmar and Louison lakes

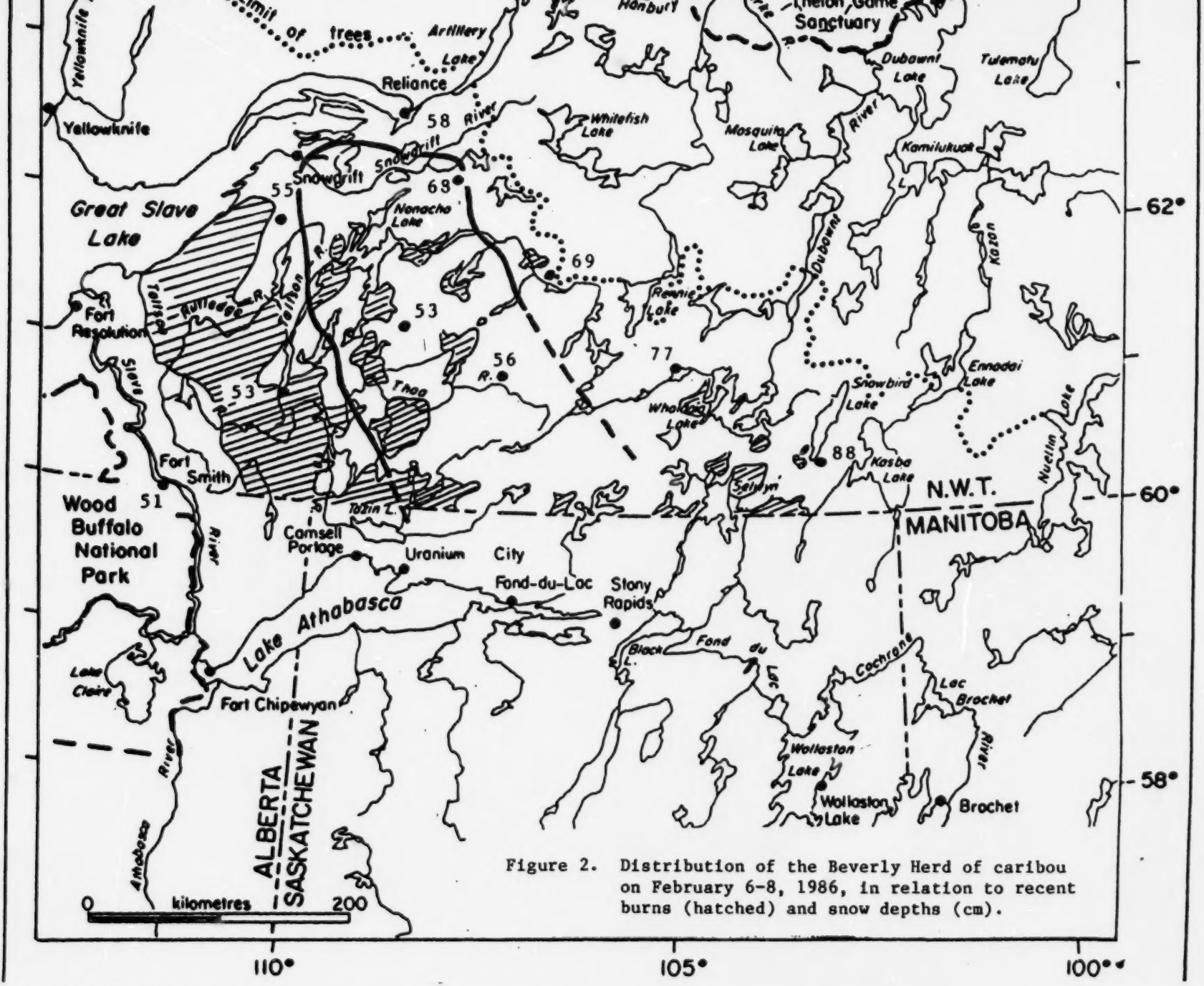

Figure 2. Distribution of the Beverly Herd of caribou on February 6-8, 1986, in relation to recent burns (hatched) and snow depths (cm).

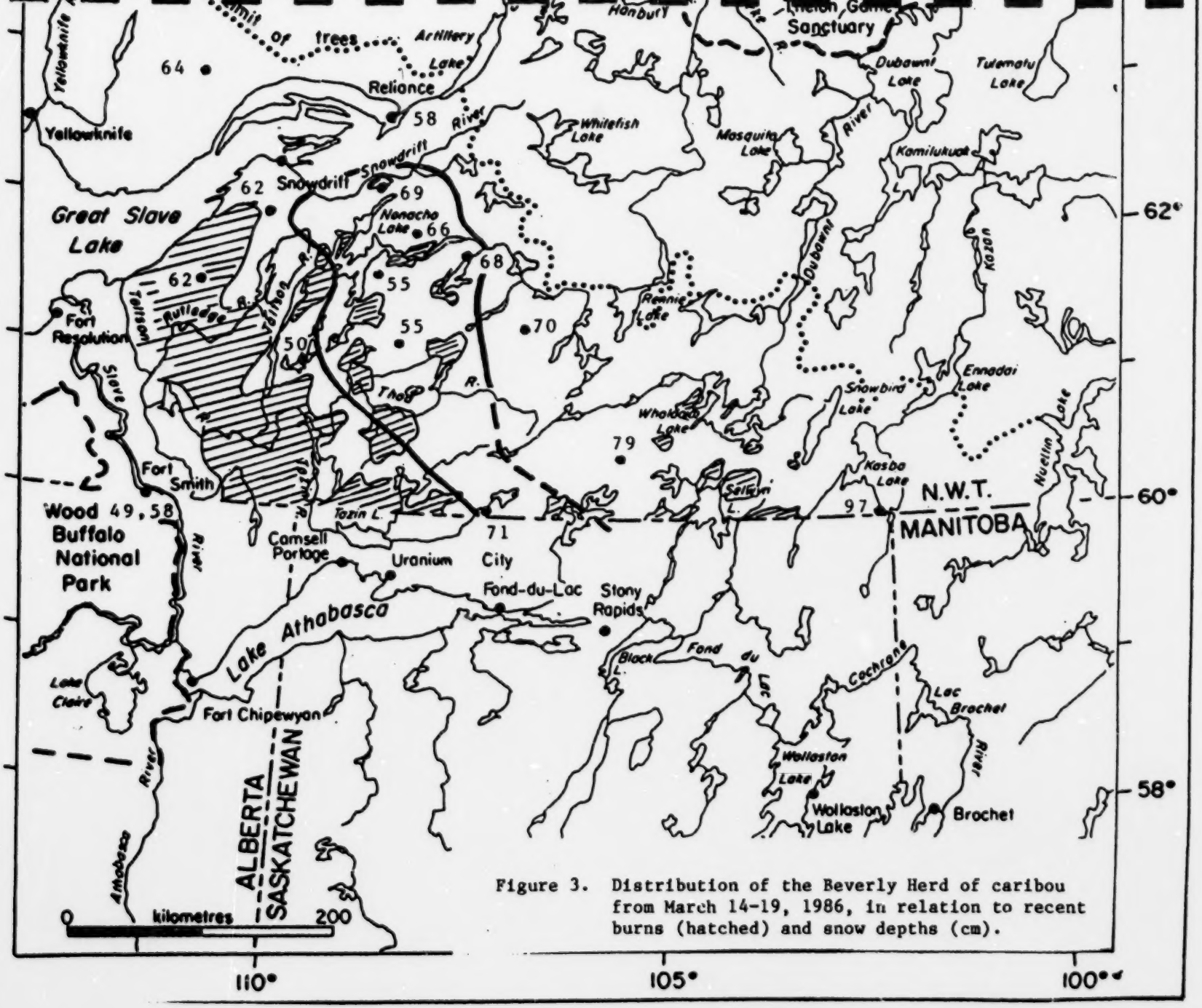

Figure 3. Distribution of the Beverly Herd of caribou from March 14-19, 1986, in relation to recent burns (hatched) and snow depths (cm).

and between Siltaza and Nonacho lakes. Subsequent surveys on March 25, 26, 28, and 29 indicated that densities were low south of 61°N and the southeastern "tail" of the distribution had narrowed to between 105°50'W and 107°20'W at 60°N. There was no clearcut direction of movement in most of the distribution. Many of the caribou were travelling in one direction on one day and in the opposite direction another day. On March 17, caribou were travelling northeast in the Siltaza Lake region and southwest on nearby Noman Lake. They were travelling north and northeast in the McKinnon Lake region on March 17 and in the opposite direction the next day when camp was positioned. The caribou appeared to be testing the northern boundary of the distribution and turned back when they encountered unfavourable conditions at treeline.

A continuous northerly movement was noted in the Thekulthili and Hjalmar lakes region on March 17 and 18. Caribou were travelling north-northwest in long lines on several main trails across Hjalmar Lake. Strong winds on March 21 drifted in the trails and stopped or slowed movement for several days. On March 26 and 29, caribou in the Taltson River and Gray and Porter lakes region had started to move northeast once again.

The distribution was about the same on April 2-5 when Mark Williams of NWT Wildlife Service conducted a calf count (Heard, pers. comm.). Some groups had reached Eileen Lake, but on April 2 and 3, most groups in the northern Nonacho and Gray lakes region were travelling southwest. Groups to the south were travelling to the northeast. By April 4, most of the caribou were travelling to the northeast ($\pm$ 45°). A similar regrouping before migration was observed

in 1967 in the same area. The result is an initial migration to the tundra on a narrow front with caribou in the forest joining the migration from the flanks.

Distribution in Relation to Burns

Figures 2 and 3 indicate that the western boundary of the distributions in February and March was near the southwestern zone where most of the range has burned since 1970. Most of the "unburned" areas west of the boundary have burned in the last 70 years (Thomas 1985). Caribou seem to prefer to forage in forests older than 70 years even though ground lichens are fairly abundant 40-70 years after fire. A good example of this preference for older forests was obvious in the vicinity of the field camp at Cobb Lake. Caribou densities were much higher in the forests over 100 years old than in the 61 year old forest a few kilometres east of camp.

In February and March, caribou continued to travel through recent burns including the large 1980 burn west of Gray Lake and south of the Taltson River. Snow depths of 66-69 cm in the region did not stop movement through burns. There appeared to be a preference for travelling on drifted lakes rather than in burns.

Distribution in Relation to Snow Depths

In early February, snow depths in the NWT varied from 51 cm to 58 cm west of a line from Reliance to Stony Rapids (Fig. 2). East of that line, depths increased from 68 cm and 69 cm near the line to 88 cm near Snowbird Lake. Depths had changed little by mid to late March in

the centre of the caribou distribution and at Reliance, but depths of 66 cm to 71 cm occurred near the eastern boundary of the distribution. Depths increased to 79 cm at Beauvais Lake and 97 cm near Kasba Lake. No icy layer of any consequence was detected at any of the snow stations. Such layers were encountered in the winters of 1979-80, 1983-84 and 1984-85. During the past seven winters, snow measurements on the winter range of the herd rarely have exceeded 60 cm.

The majority of the herd spent February and March in an area with favourable snow conditions, that is, less than 60 cm of snow. Where the snow was deeper (66-69 cm) in the Porter, Gray, and Noman lakes region the caribou were attempting to travel to the north and east, but were turning back on their own trails. This behaviour was judged to be a response to the deeper snow and unfavourable feeding conditions on the tundra. Caribou continued to crater in snow up to 71 cm deep. The only observation of caribou tracks in deeper snow was at Smalltree Lake in early February where the snow was 77 cm deep. A group of caribou was not feeding in the forest, but in the tundra patches where the snow was thinner because of drifting.

Radio-tracking of Collared Caribou

All 67 frequencies provided by Doug Heard (pers. comm.) were monitored on three flights in February (Fig. 4) and two flights in March (Fig. 5). No signals were heard. The receiver was checked with a transmitter in a collar left at the Fort Smith airport.

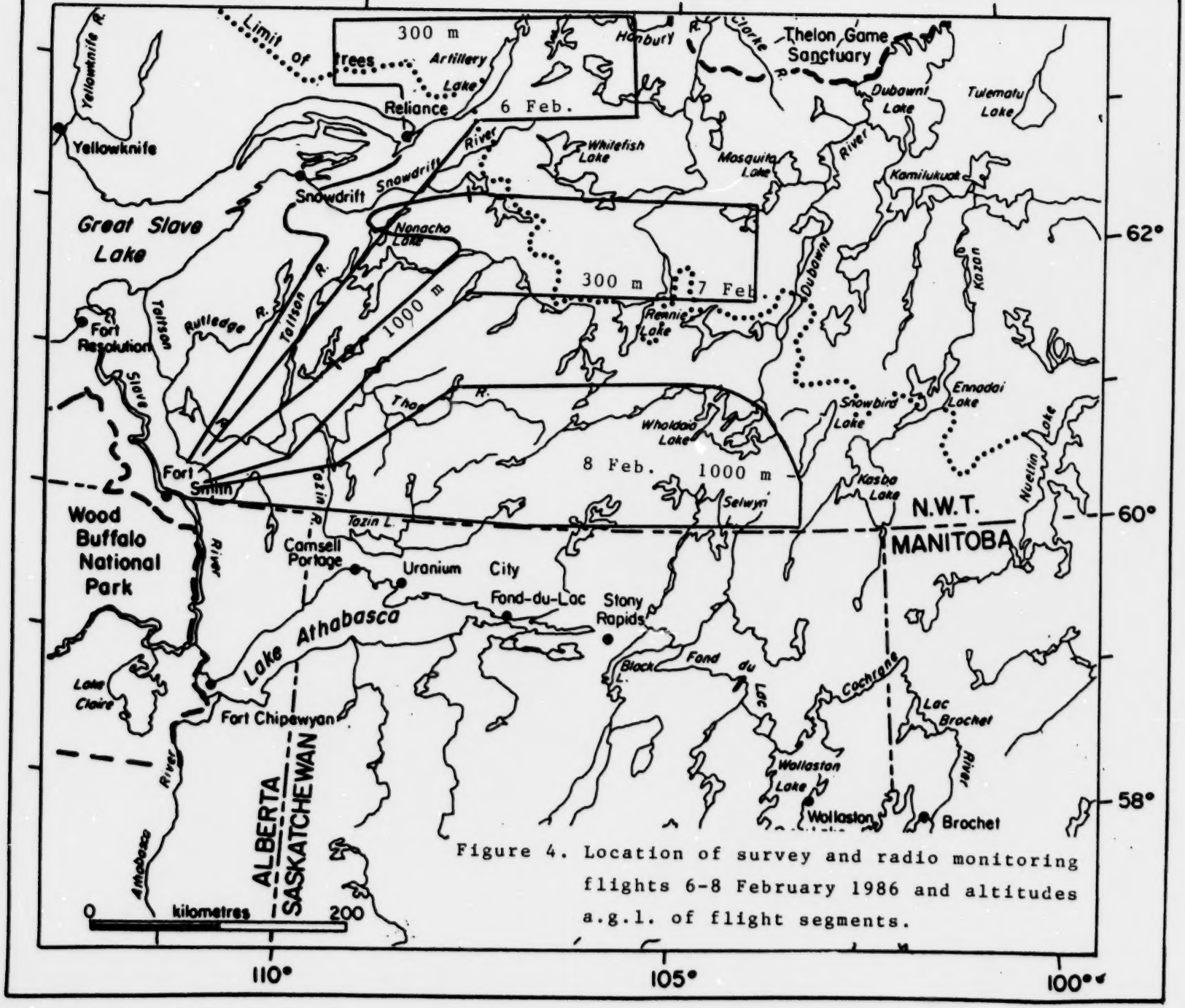

Figure 4. Location of survey and radio monitoring flights 6-8 February 1986 and altitudes a.g.l. of flight segments.

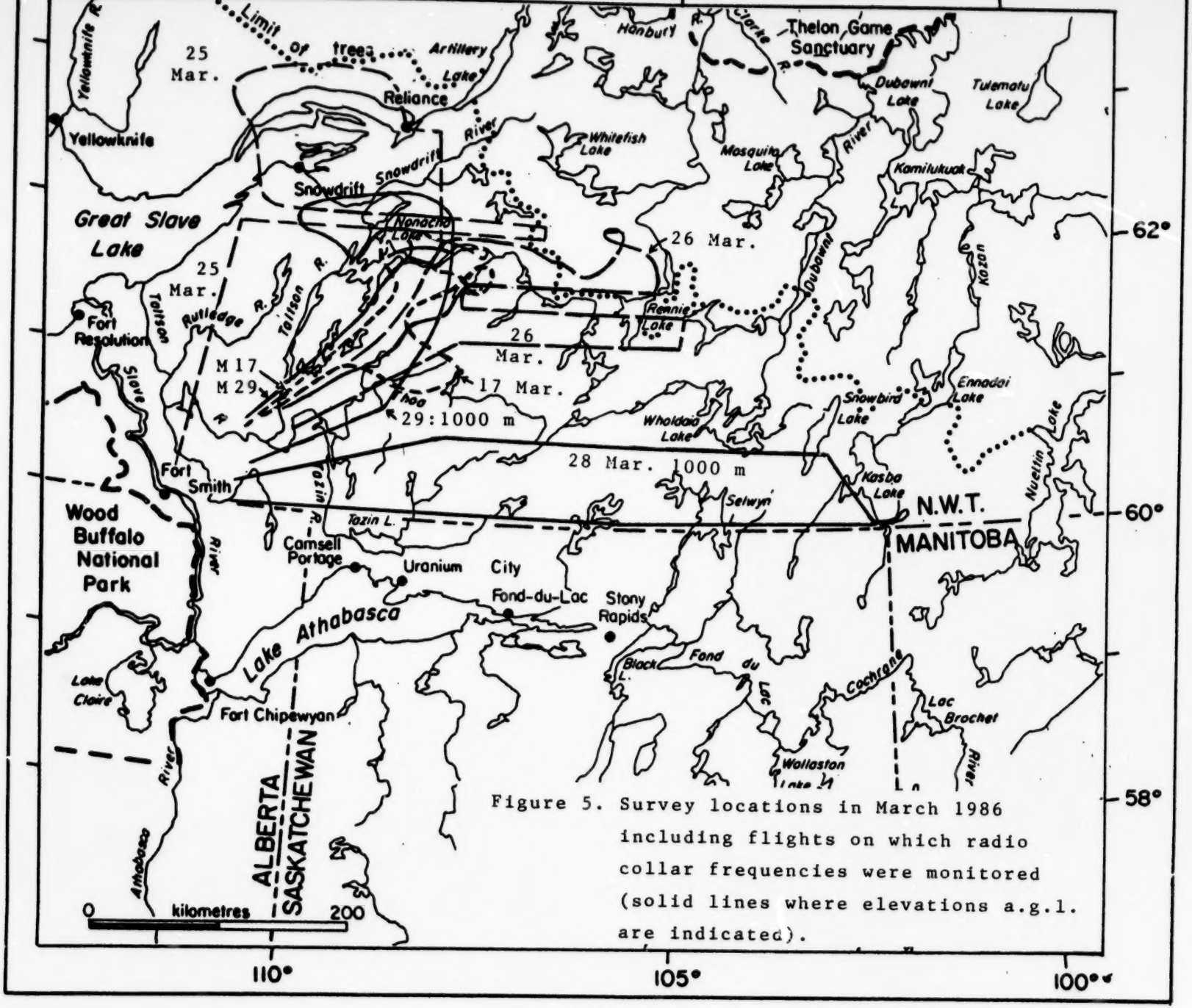

Figure 5. Survey locations in March 1986 including flights on which radio collar frequencies were monitored (solid lines where elevations a.g.l. are indicated).

CONCLUSIONS

1. The range used by the Beverly Herd in winter 1985-86 was adequate in quantity and quality judging from overwinter changes in the fat reserves of sampled caribou.
2. Deposition of fat during the winter was largely internal as opposed to subcutaneous (mantle) fat.
3. Fat reserves were lower in 1985-86 than in 1984-85 and similar to the lowest values in previous years.
4. These data confirm the close relationship between physical condition and fertility: the lower fat reserves in winter 1985-86 was mirrored by a relatively low pregnancy rate which matched the previous low in 1982-83.
5. The sex ratio of offspring is influenced by the age structure of the population because young females produce a majority of female young which is reversed in old females.
6. The emergence of warble larvae is slower in older females than in young ones or they are infected later because of differences in the timing of summer movements.
7. The degree of infection with warble larvae appears to influence condition, although there is a possibility that animals in poorer condition may be more susceptible to warble flies or the development of their larvae.
8. Young females 2½-5 years old seemed to be more affected by parasites, including warble larvae and hydatid cysts, than other sex/age classes.

9. Most of the Beverly Herd spent most of the winter in a favourable area between regions of deep snow and young forests.
10. Earlier comments that caribou prefer forests over 70 years old (Thomas 1985) to younger ones were supported by observations in March in the Cobb Lake region.
11. The recruitment rate (addition of calves nearing their first birthday) is expected to decline in March-April 1987 because of the lower pregnancy rate and the poorer condition of pregnant females.

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